October 28-29, 2025
Orlando, FL

TRANSPORTATION SYMPOSIUM

Fowler Avenue Pedestrian and Bicycle Intersection Safety Improvements FPIN: 447696-1

Tina Russo, LCI 395 – D7 Bicyclist and Pedestrian Program Manager
Allie Caldwell – FDOT Central Office- Roadway Design
Andrew Gray, PE, RSP2I – D7 Bicyclist and Pedestrian Safety Consultant

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Agenda

- Project Overview
- Tight Right Turn Channelization
- Bulb Outs
- Median Refugee Islands
- Missing Crosswalks
- LED Lighting Retrofit
- Buffered Bike Lanes
- Leading Pedestrian Interval
- Other D7 Projects Using Fowler Avenue Designs

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Key Concepts

- Bicycle and Pedestrian safety is not one size fits all
- Understand safety countermeasures that can be used…
  - With different intersection sizes and configurations
    - Each corner of an intersection can be designed differently
  - With different budgets
  - With different crash and behavioral concerns

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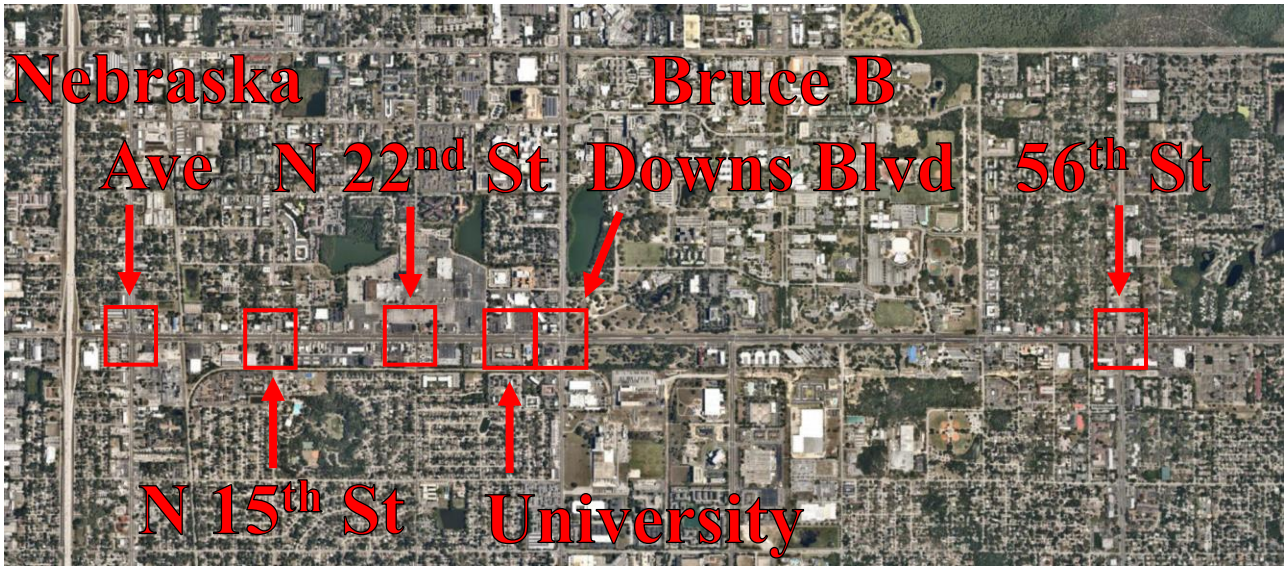

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Cross Street	Bicycle & Pedestrian Crash Severity	Bicycle & Pedestrian Crashes Before Construction (2016 - 2020)
Nebraska Avenue (US 41)	Fatal & Serious Injury	5
	Other Severity	6
N 15th Street	Fatal & Serious Injury	3
	Other Severity	19
N 22nd Street	Fatal & Serious Injury	2
	Other Severity	8
University Commons	Fatal & Serious Injury	0
	Other Severity	2
Bruce B Downs Boulevard/30th Street	Fatal & Serious Injury	0
	Other Severity	6
56th Street (SR 583)	Fatal & Serious Injury	1
	Other Severity	10

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FDM 212.12.2

212.12.2 Turning Roadways with Corner Islands

Consider providing a corner island at an intersection where paved areas are excessively large or do not establish proper channelization of traffic. Corner islands can provide delineation for through and turning traffic. In addition, corner islands shorten crosswalks and give pedestrians and bicyclists a refuge area. See ***FDM 210.3.2*** for island requirements.

Channelized right-turn lanes can be designed with a flat or near perpendicular angle of entry to the cross street (see ***Figure 212.12.3***). The flat angle of entry is most appropriate for higher-speed turning movements with no pedestrian accommodations. Large turning radii and angles of entry into the cross street allow higher turning speeds, reduced traffic delays, and the turning movement of large trucks. The higher speeds, angle of entry and large radii adversely impact pedestrian safety at the crosswalk.

The near perpendicular angle of entry is preferred where pedestrian facilities are provided. Tight turning radii and angles of entry into the cross street accommodate the following:

- Slower turning speeds,
- Reduced cross walk length,
- Improved pedestrian visibility,
- Improved sight distance,
- Decreased angle of driver head turning,
- Reduced right-of-way impacts.

Consider the near perpendicular right-turn lane design in ***Figure 212.12.4*** when the following conditions are met:

- Context Classifications C2T, C3, C4, C5 and C6
- Low-speed roadway (design speeds of 45 mph and less)
- Pedestrian traffic is expected
- No acceleration lane is provided

This design includes the previously-mentioned benefits to passenger cars and pedestrians with striping and a scalene triangle shaped corner island. An approaching deceleration lane is preferred to provide vehicles additional time to stop for crossing pedestrians. The crosswalk is set back 20 feet minimum from the end of the island to allow room for a passenger car to wait for a gap in traffic without blocking the crosswalk. As shown in ***Figure 212.12.4***, the outside curb radii can be designed to accommodate over-tracking of large vehicles such as single-unit trucks, transit, or Florida Interstate Semi-trailers (WB-62FL).

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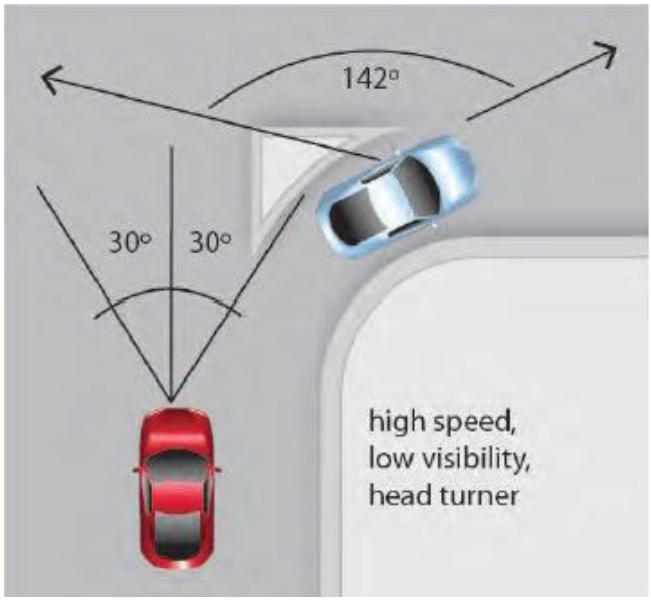
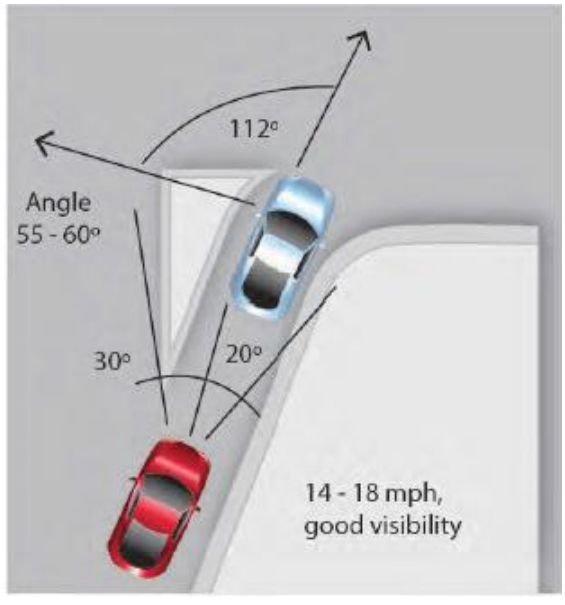


Traditional Wide Design



New Tight Design

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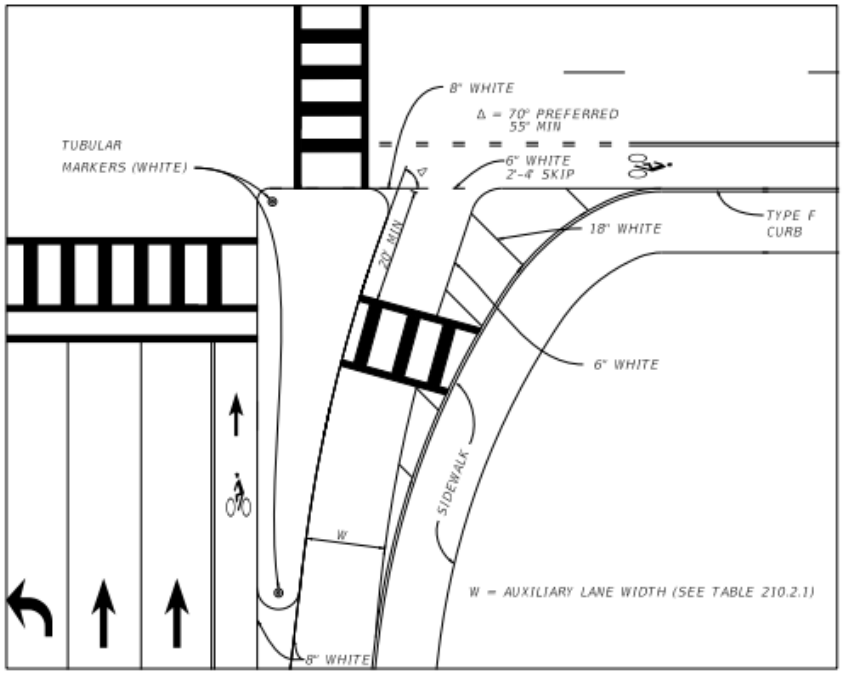
Figure 212.12.4 Near Perpendicular Right-Turn Lane



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56th Street

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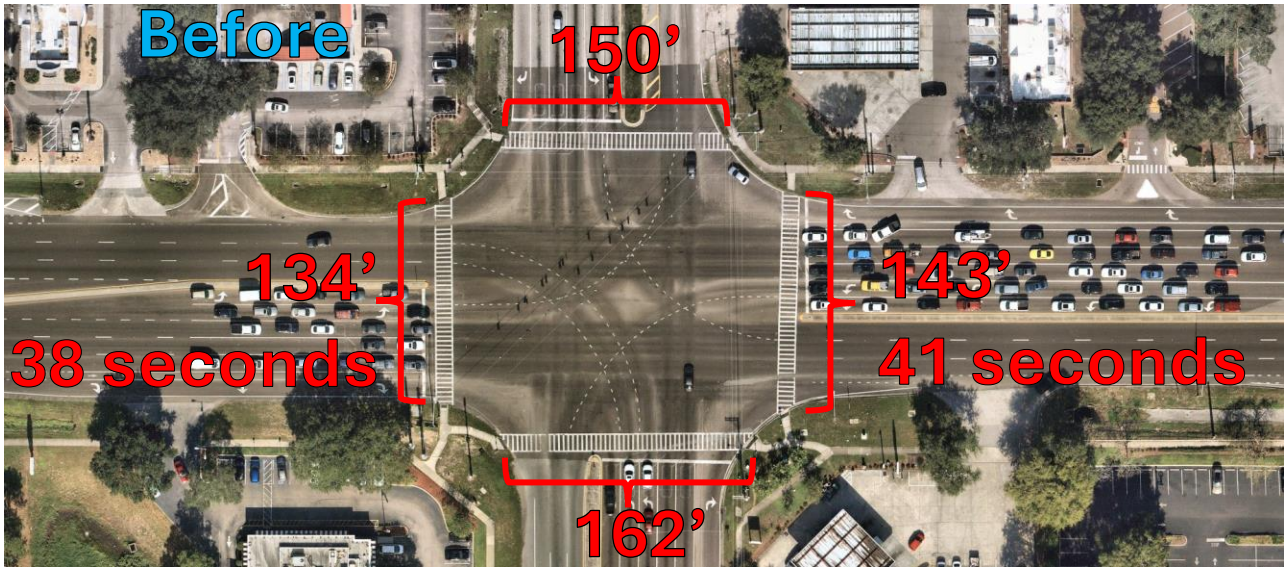
43 seconds



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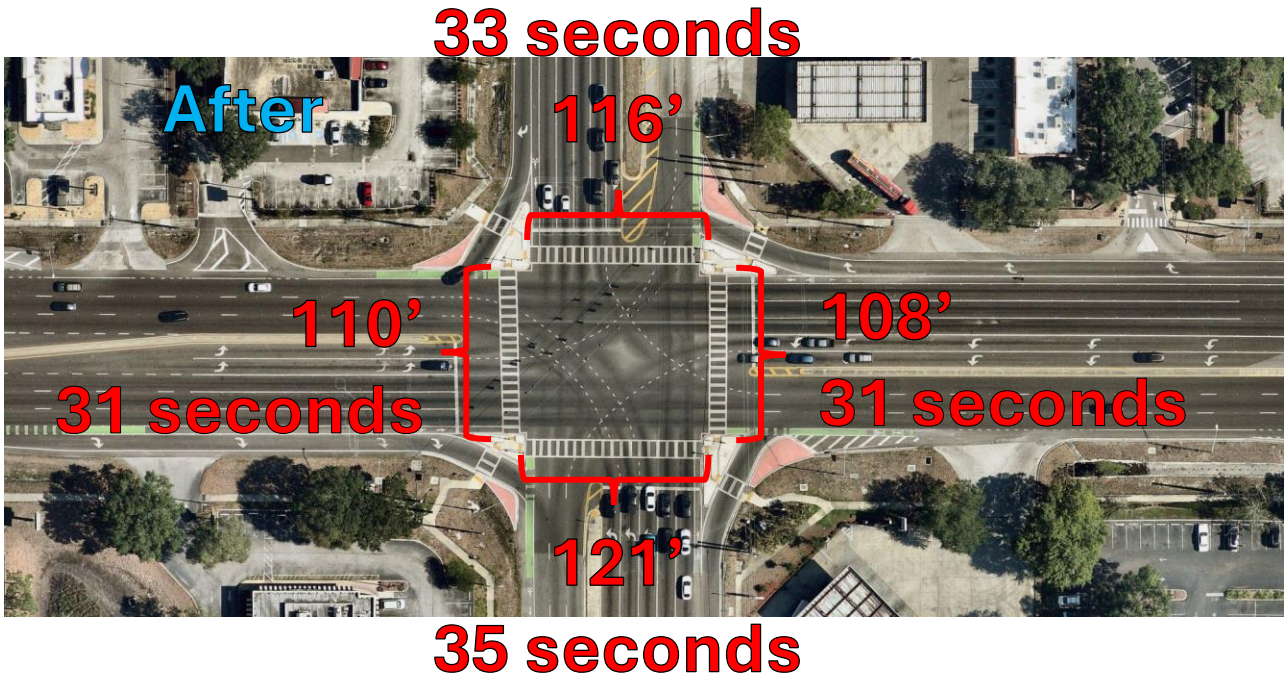
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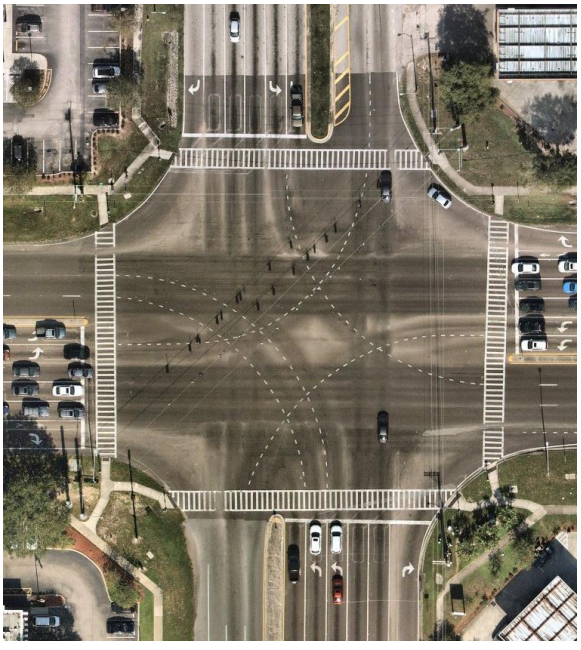

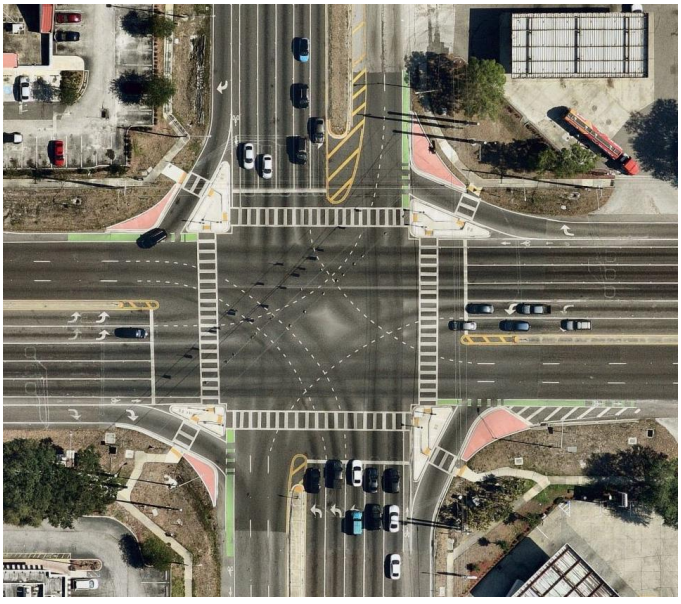

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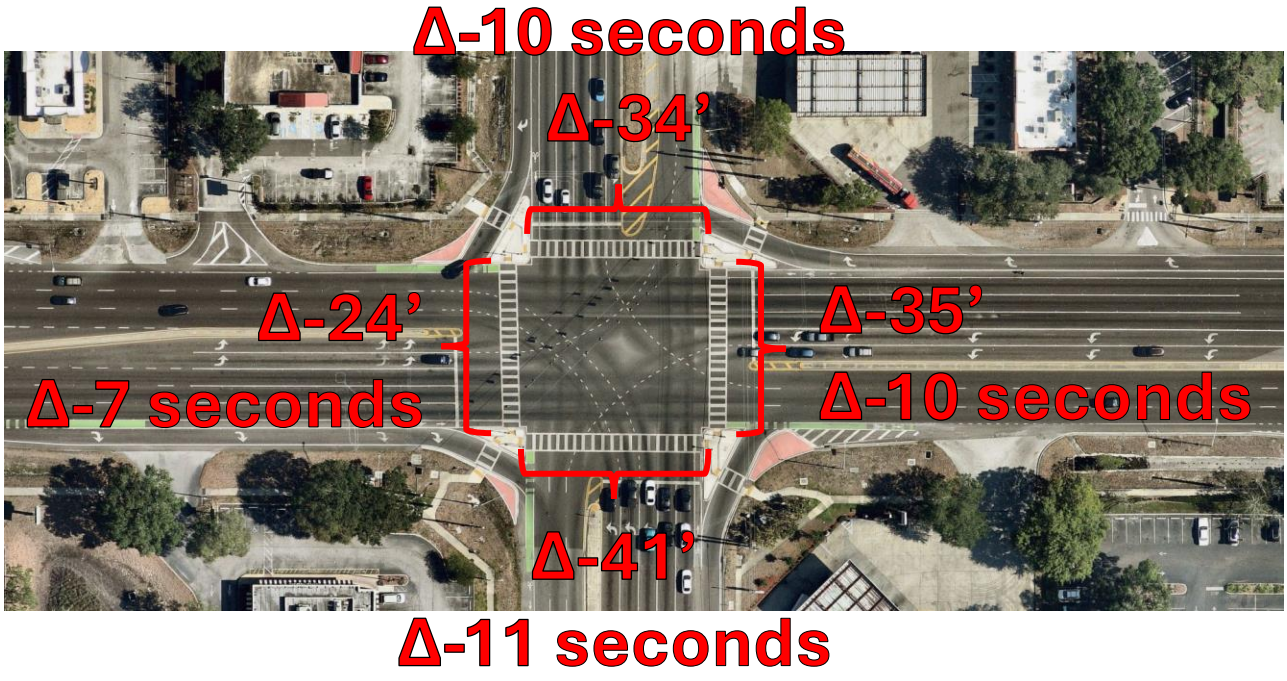
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Δ-34’
Δ-24’
Δ-35’
Δ-7 seconds
Δ-10 seconds
Δ-41’
Δ-11 seconds

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Bruce B Downs Boulevard/30th Street

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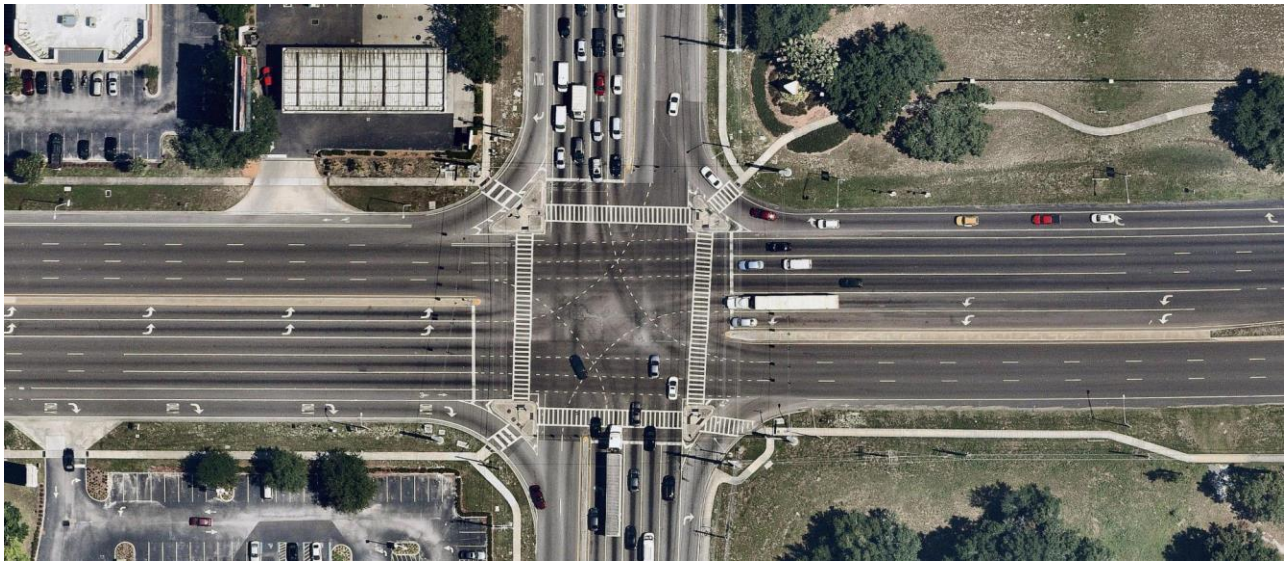

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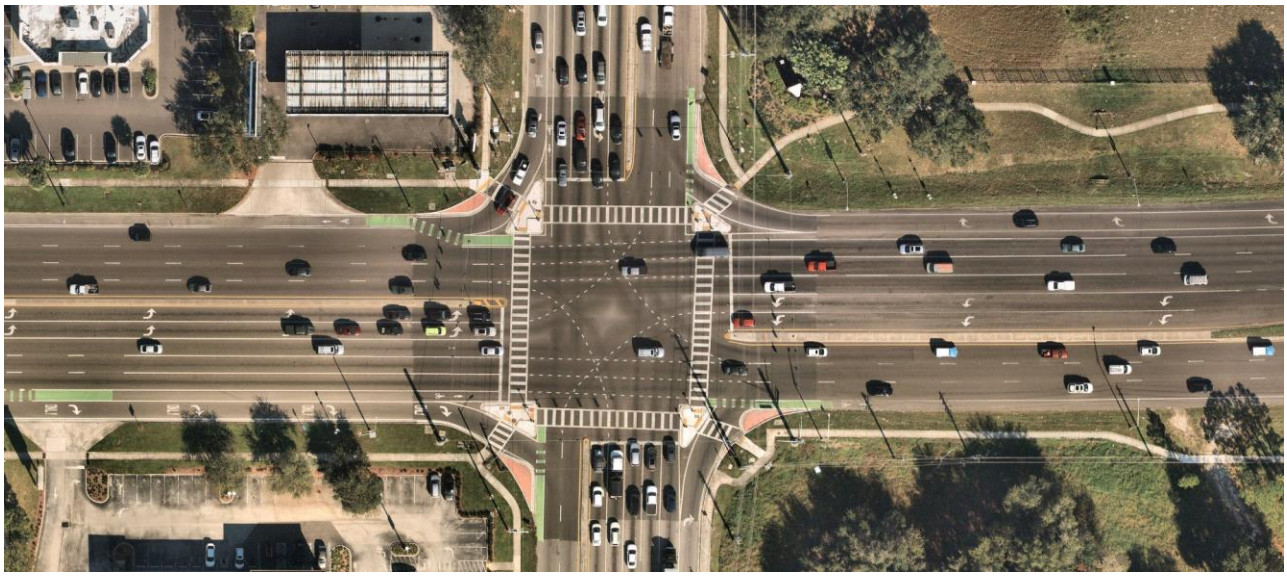

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Bulb Outs
Nebraska Avenue

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FDM 202.3.12

202.3.12 Curb Extensions (Bulb-Outs)

Curb extensions are portions of the curb line extended out into the roadway to provide engagement and deflection. Curb extensions are commonly used at either end of a parking lane. They also shorten the crossing distance for pedestrians and may provide space for landscaping or community aesthetic features.

Curb extensions create engagement by extending the curb line to be adjacent to the travel lane. When used at the beginning of a parking lane or as part of a chicane, the curb extension also provides deflection. In some instances, longitudinally extended bulb-outs inside the existing curb lines may be used to narrow the entire length of a roadway segment. In this case, the existing drainage system is preserved, and drainage is provided through the new curb extensions to existing inlets. Curb extensions at intersections should be designed using a CADD-based vehicle turning path (e.g., AutoTurn) to verify the appropriate design and control vehicles are accommodated.

See ***FDM 222.2.6*** for curb extension criteria.

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FDM 222.2.6

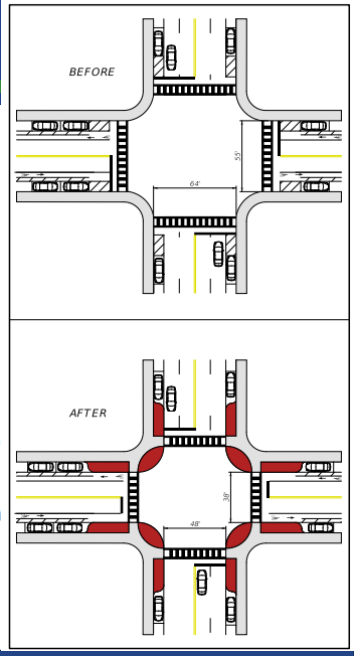
222.2.6 Curb Extensions (Bulb-Outs)

Consider the use of curb extensions (a.k.a., bulb-outs) in conjunction with on-street parking at intersections or midblock locations where there is a crosswalk, provided there is adequate width for existing traffic movements. Curb extensions shorten the crossing distance, and provide additional space at intersections, allowing pedestrians to see and be seen before entering a crosswalk.

The design of curb extensions must take into consideration the needs of transit, emergency vehicles, commercial trucks, drainage, and bicyclists.

Consult with District drainage staff on drainage accommodations for the curb extension during Phase I of the design. See the ***Drainage Design Guide*** and ***Figure 222.2.1***.

Figure 222.2.1 Curb Extension



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222.3 Detectable Warnings

Detectable warnings are a distinctive surface pattern of domes detectable by cane or underfoot that alert people with vision impairments of their approach to street crossings. Install detectable warnings to cover the full width of the walking surface and be 2 feet deep. They are required on sidewalks at the following locations:

- Curb ramps and transition areas at street crossings
- Pedestrian refuge islands where there is one or more of the following:
  - Change in surface texture
  - Change in elevation (e.g., curb ramp)
  - Change in horizontal alignment of the path within the refuge island
  - Two-stage crossings
- Pedestrian at-grade railroad crossings
- Commercial driveways with a stop sign, yield sign, or traffic signal
- Boarding and alighting areas adjacent to the roadway at bus stops where there is an at-grade connection to the roadway
- Edges of railroad boarding platforms not protected by screens or guards

Detectable warnings should not be placed where sidewalks intersect urban flared driveways or on sidewalks that run continuously through residential driveways. Do not place detectable warnings on transition slopes or over grade breaks. Further guidance on detectable warnings is provided in ***Standard Plans, Index 522-002***.

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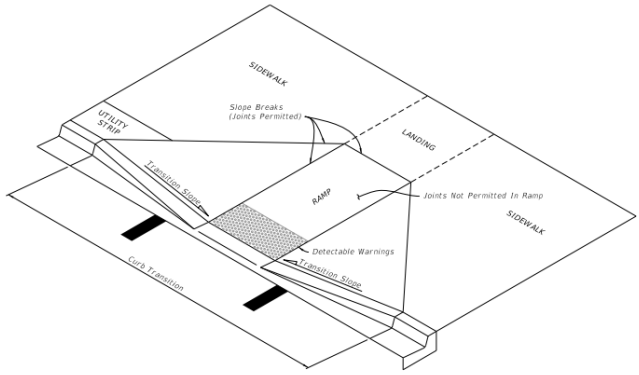
GENERAL NOTES:

1. Cross Slopes and Grades:
   - A. Sidewalk, ramp, and landing slopes (i.e. 0.02, 0.05, and 1:12) shown in this Index are maximums. With approval of the Engineer, provide the minimum feasible slope where the requirements cannot be met.
   - B. Landings must have cross-slopes less than or equal to 0.02 in any direction.
   - C. Maintain a single longitudinal slope along each side of the curb ramp. Ramp slopes are not required to exceed 15 feet in length.
   - D. Joints permitted at the location of Slope Breaks. Otherwise locate joints in accordance with Index 522-001. No joints are permitted within the ramp portion of the Curb Ramp.
2. Curb, Curb and Gutter and/or Sidewalk:
   - A. Refer to Index 522-001 for concrete thickness and sidewalk details.
   - B. Remove any existing curb, curb and gutter, or sidewalk to the nearest joint beyond the curb transition or to the extent that no remaining section is less than 5 feet long.
   - C. Width of Curb Ramp is 4'-0" minimum. Match sidewalk or Shared Use Path width as shown in the Plans.
3. Curb Ramp Alpha-Identification:
   - A. Sidewalk curb ramp alpha-identifications (e.g. CR-A) are provided for reference purposes in the Plans.
   - B. Alpha-identifications CR-I and CR-J are intentionally omitted.
4. Detectable Warnings:
   - A. Install detectable warnings in accordance with Specification 527.
   - B. Place detectable warnings across the full width of the ramp or landing, to a minimum depth of 2 feet measured perpendicular to the curb line and no greater than 5 feet from the back of the curb or edge of pavement.
   - C. If detectable warnings are shown in the Plans on slopes greater than 5%, align the truncated domes with the centerline of the ramp; otherwise, the truncated domes are not required to be aligned.



CURB RAMP NOMENCLATURE

LAST REVISION	DESCRIPTION:	FDOT	FY 2025-26 STANDARD PLANS	DETECTABLE WARNINGS AND SIDEWALK CURB RAMPS	INDEX	SHEET
11/01/21					522-002	1 of 7

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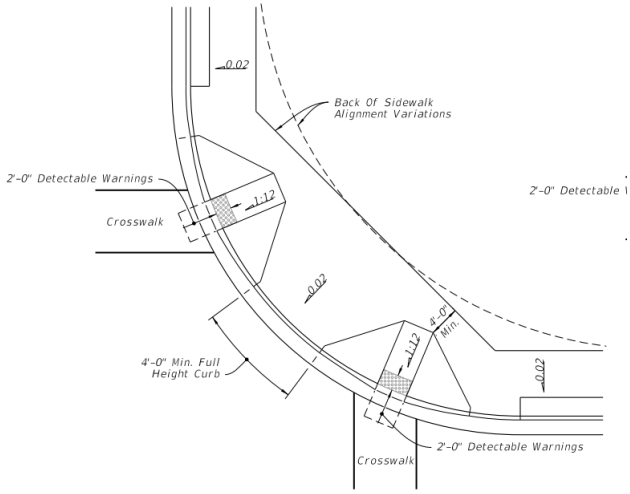

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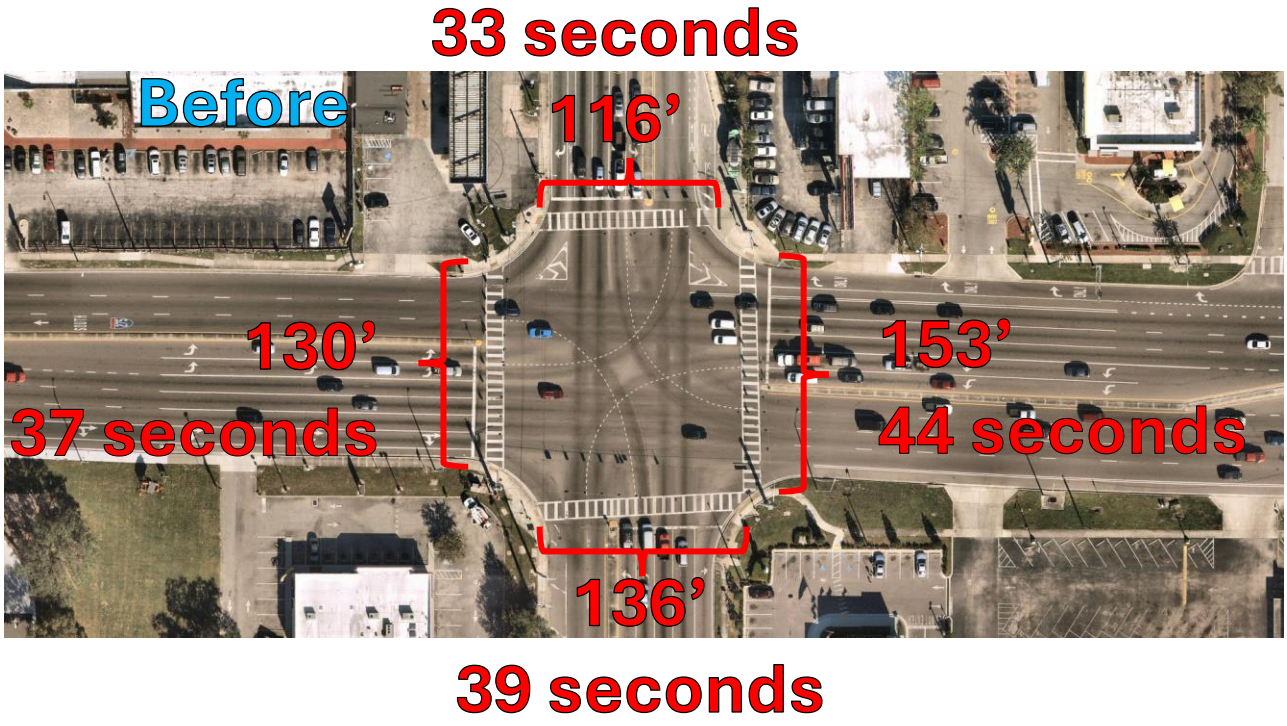
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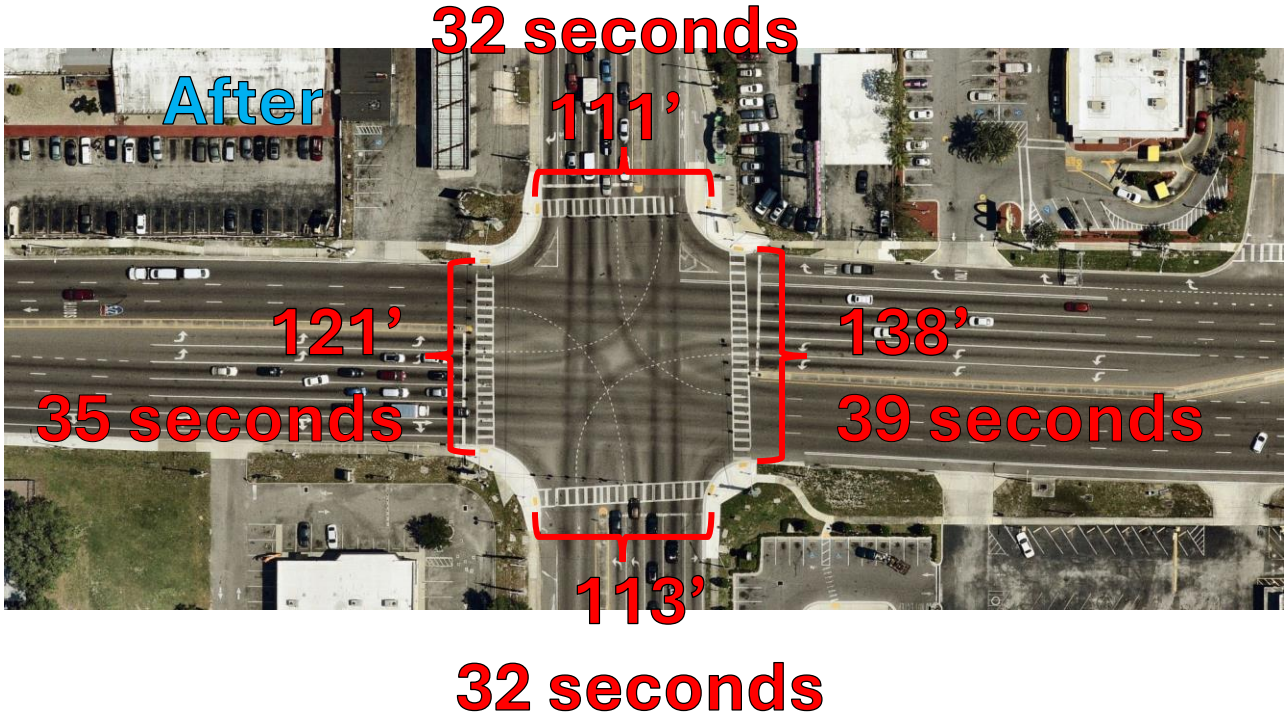
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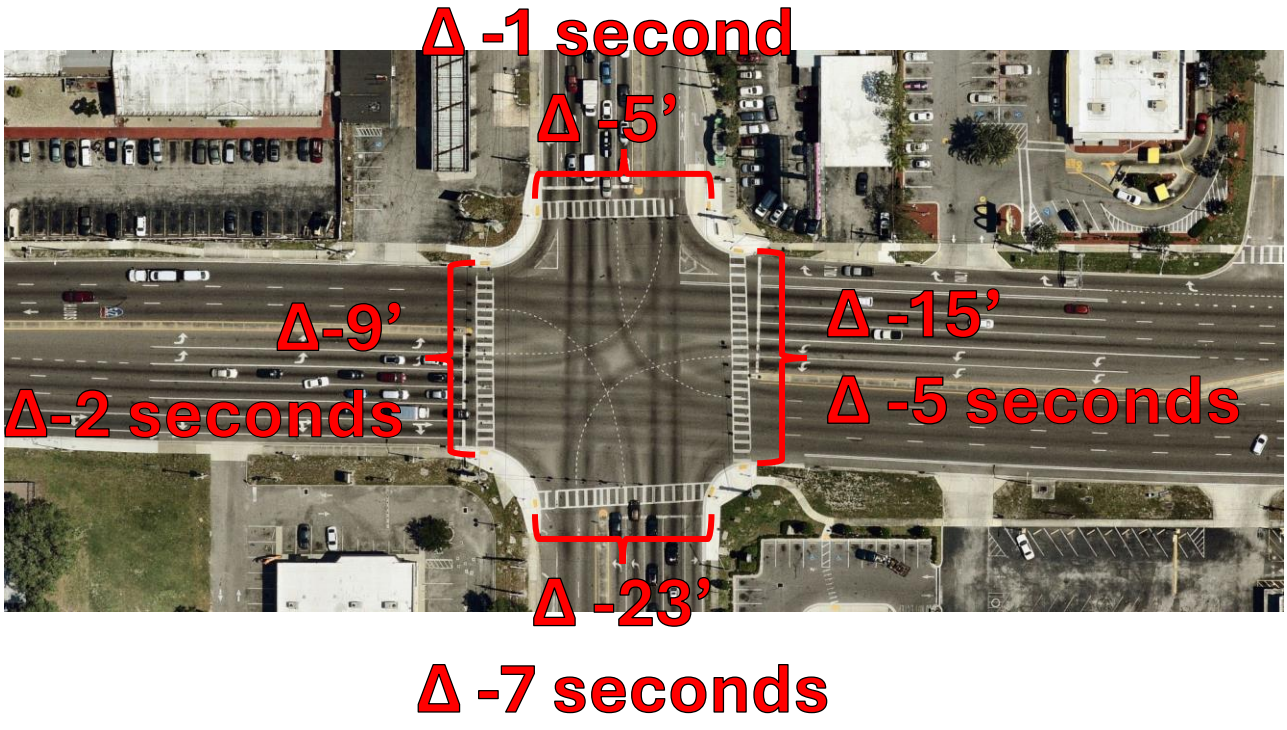

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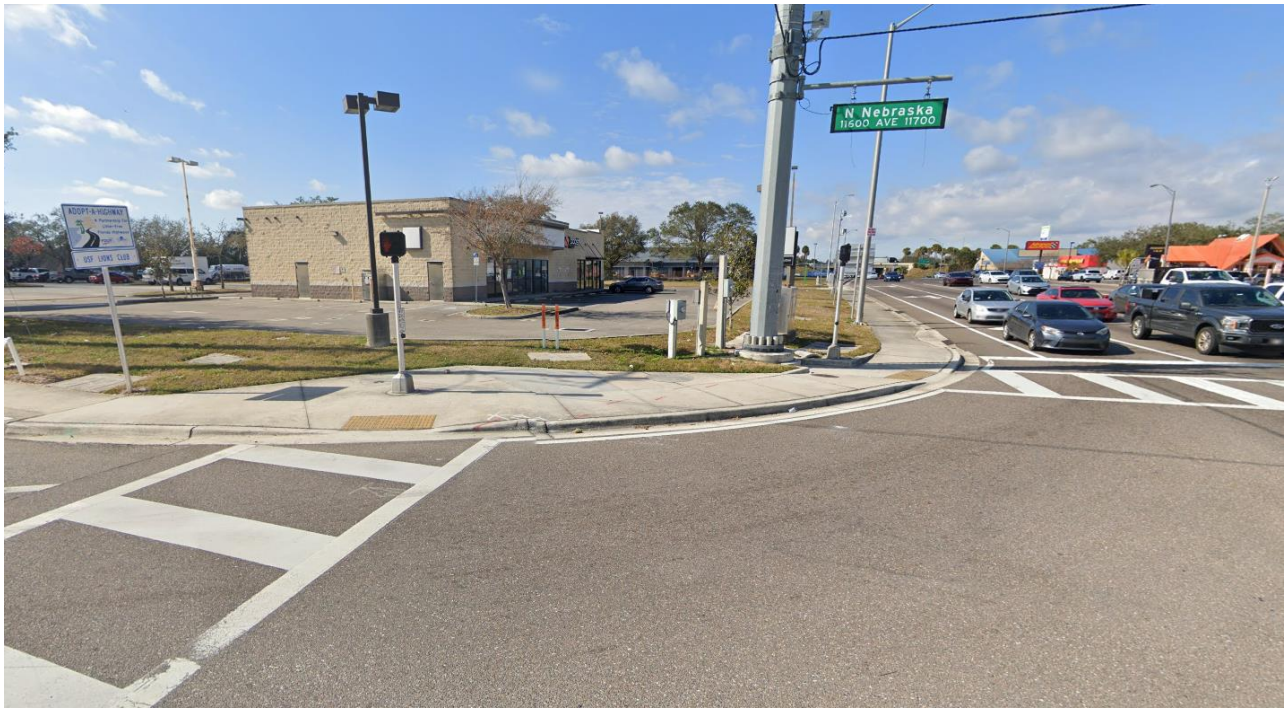

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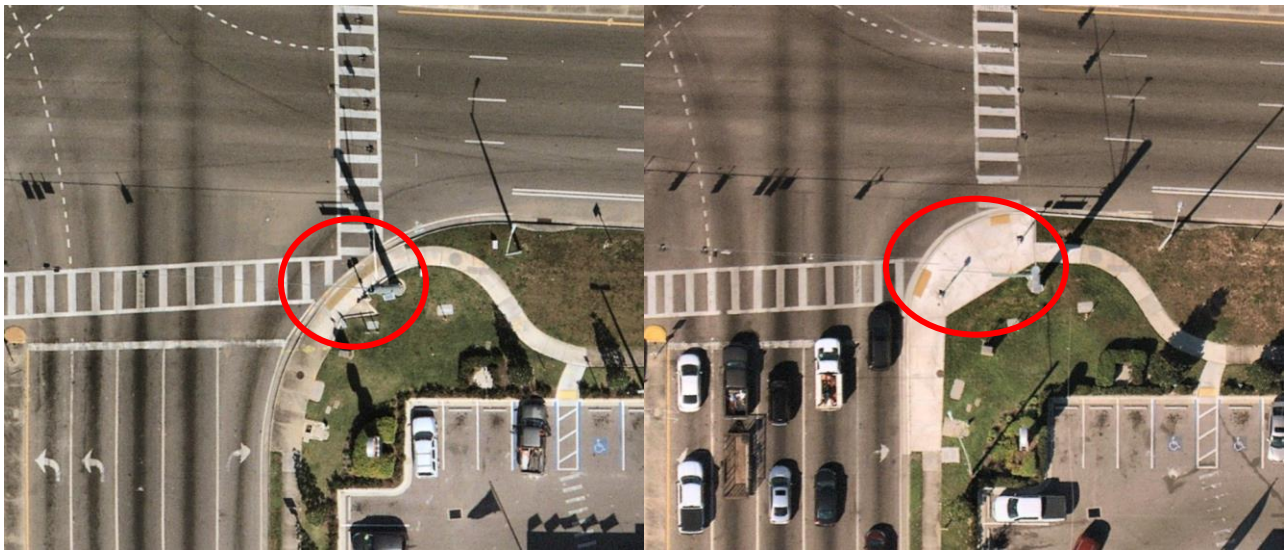

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Tight Right Turn Channelization Before and After Study

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Methodology

- Data Collection Dates
  - Before: Wednesday, May 12th, 2021
  - After: Wednesday, May 18th, 2022
- Three Intersections
  - Fowler Avenue @ 56th Street
  - Fowler Avenue @ Bruce B Downs Boulevard (30th Street)
  - Fowler Avenue @ Nebraska Avenue (US 41)
- Behavioral Analysis
  - Right Turning Vehicle Speed
  - Drivers Yielding to Pedestrians

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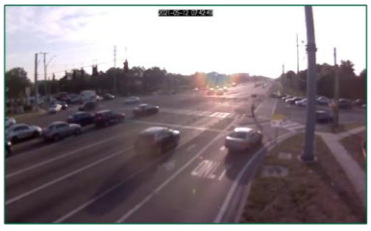
	Fowler Avenue @ 56th Street	Fowler Avenue @ Bruce B Downs Boulevard	Fowler Avenue @ Nebraska Avenue
Before			
After			

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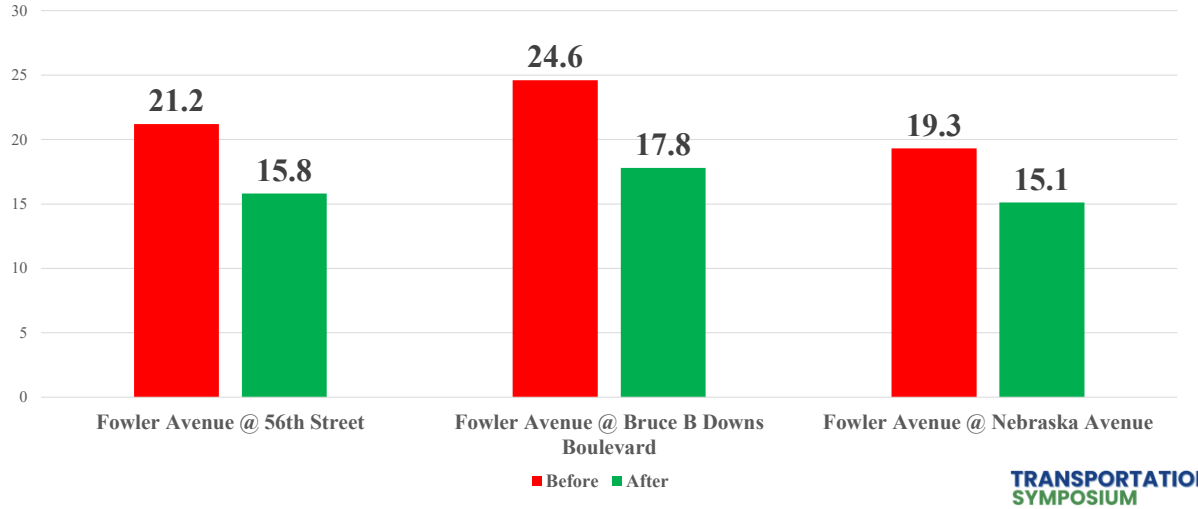
Right-Turn Speed (mph) by Intersections



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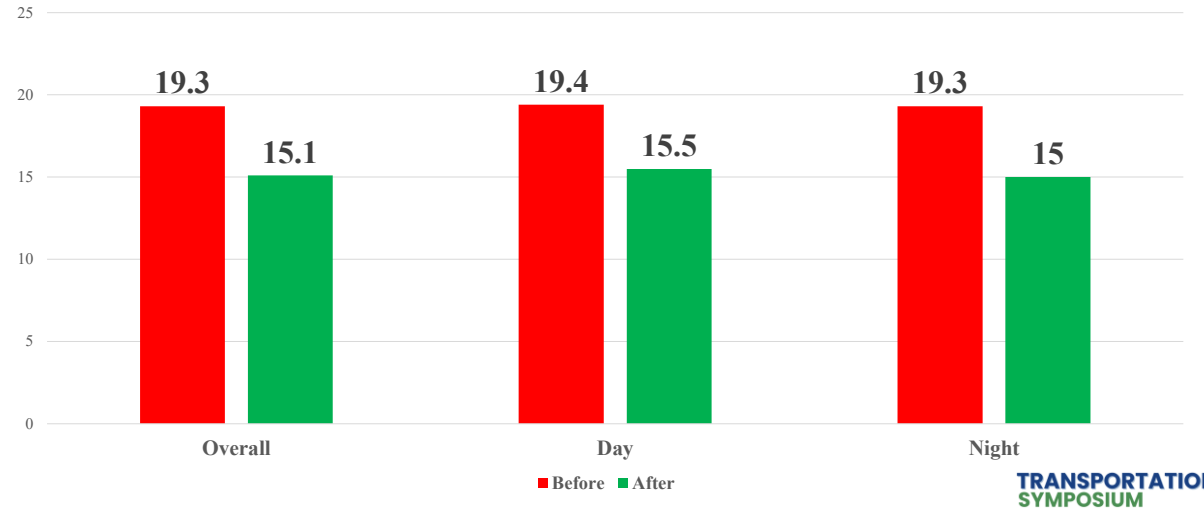
Overall Right Turning Speeds (mph)



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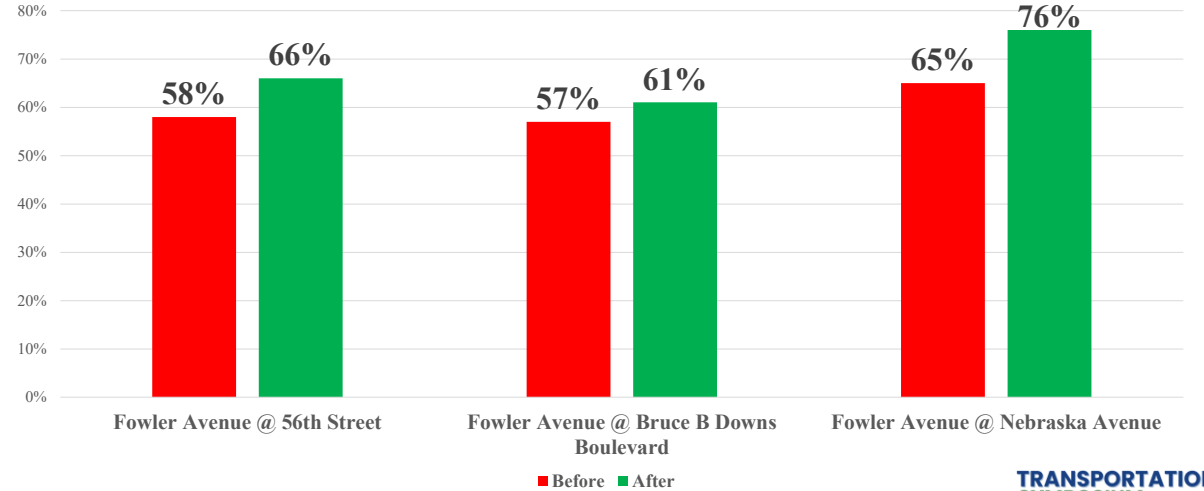
Rate of Drivers Yielding to Pedestrians by Intersection



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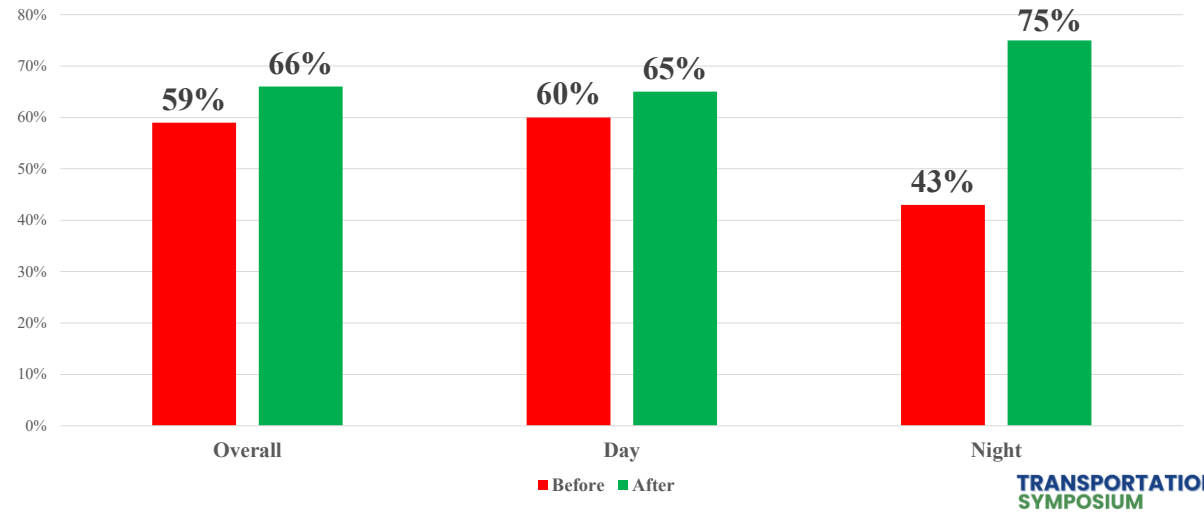
Rate of Drivers Yielding to Pedestrians by Time of Day



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Conclusions

- Reduced right-turn speeds by **21.8%**
  - More significant at night (**22.3%**)
- Increased driver yielding-to-pedestrian rate by **7%** (From 59% to 63%)
  - More significant at night (**32%** increase from 43% to 75%)
- New tight right-turn design **significantly improves pedestrian safety**

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Bulb Outs
North 15th Street

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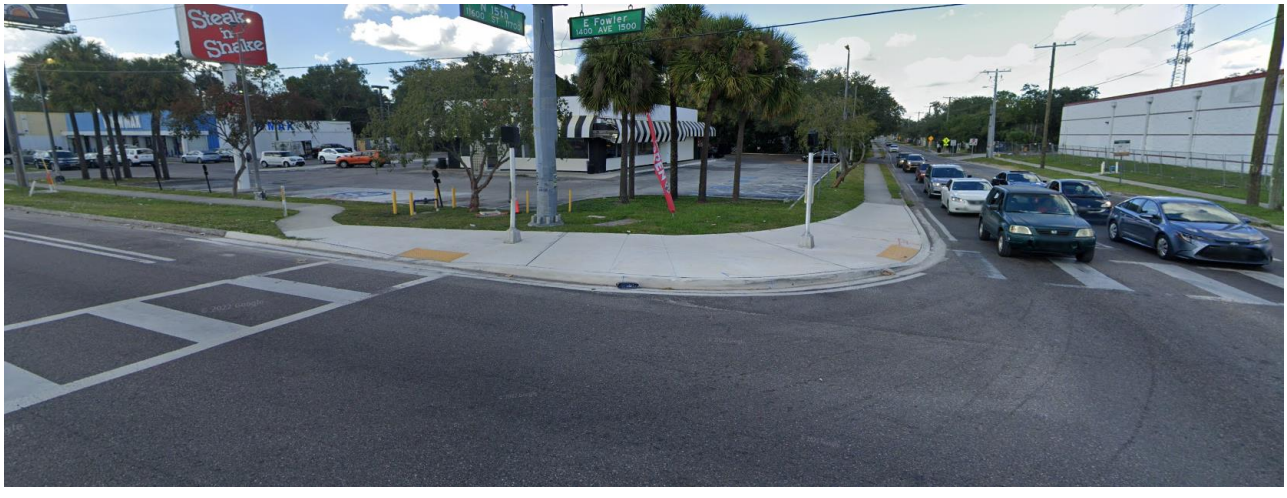

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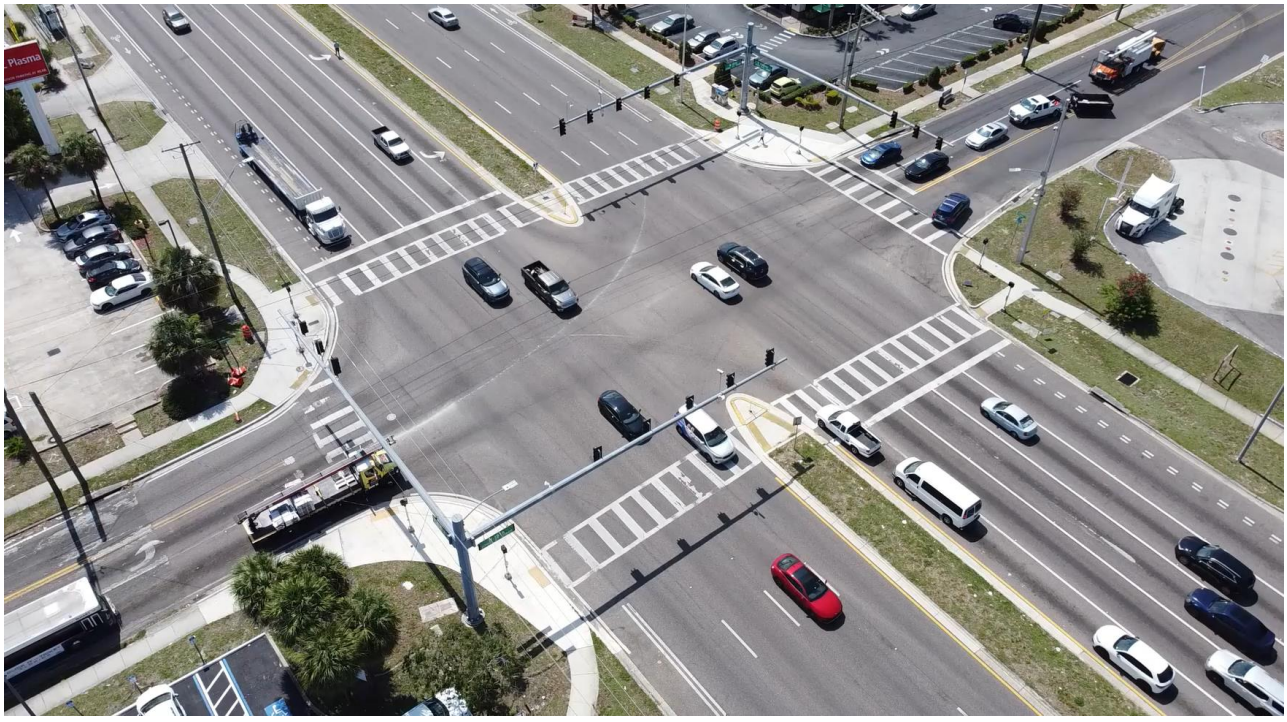

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Hardened Centerline and Median Refugee North 22nd Street

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Figure 210.3.6 Hardened Centerline with Traffic Separator

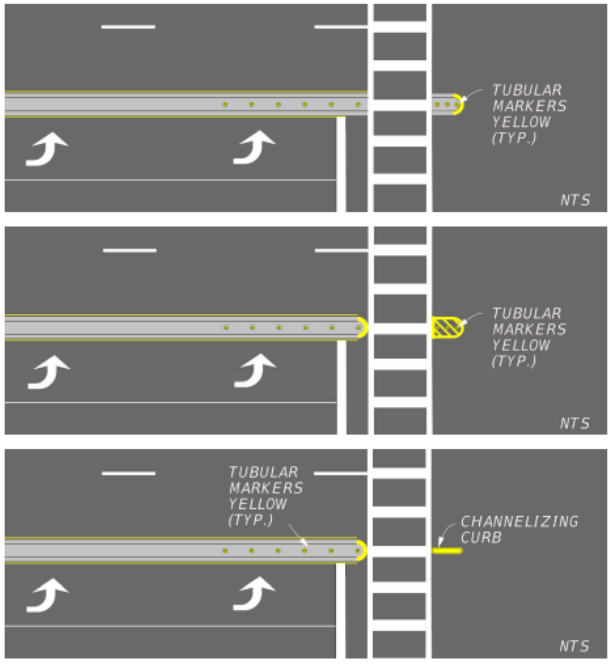

Figure 210.3.7 Hardened Centerline without Traffic Separator

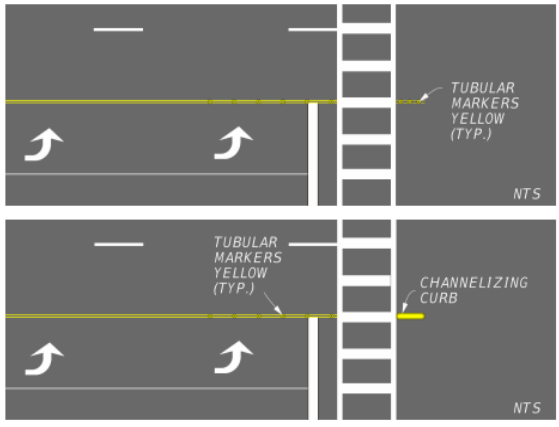

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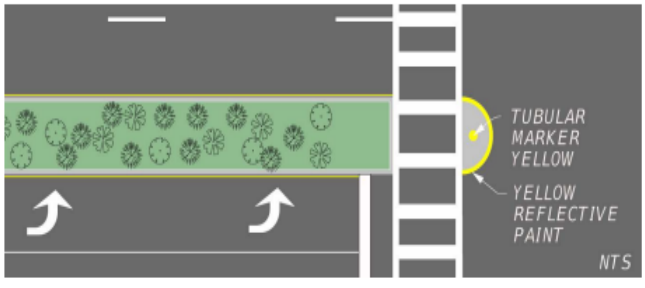
Figure 210.3.3 Intersection Refuge Island (Cont.)

For New and Reconstruction Projects with Depressed Crossings:



For RRR Projects Where Concrete Median Nose is Not Constructible in Constrained Conditions:

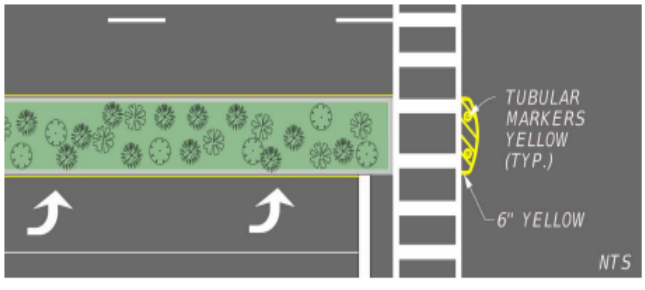
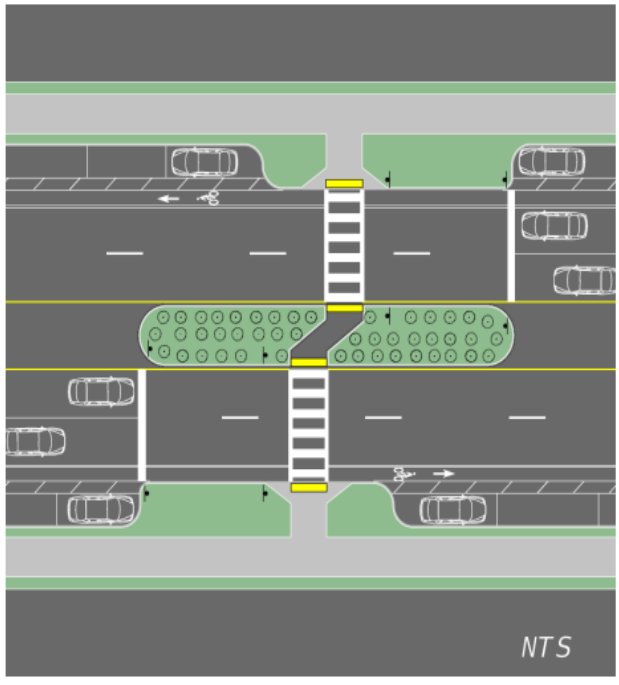


Figure 210.3.4 Midblock Refuge Island Example #1



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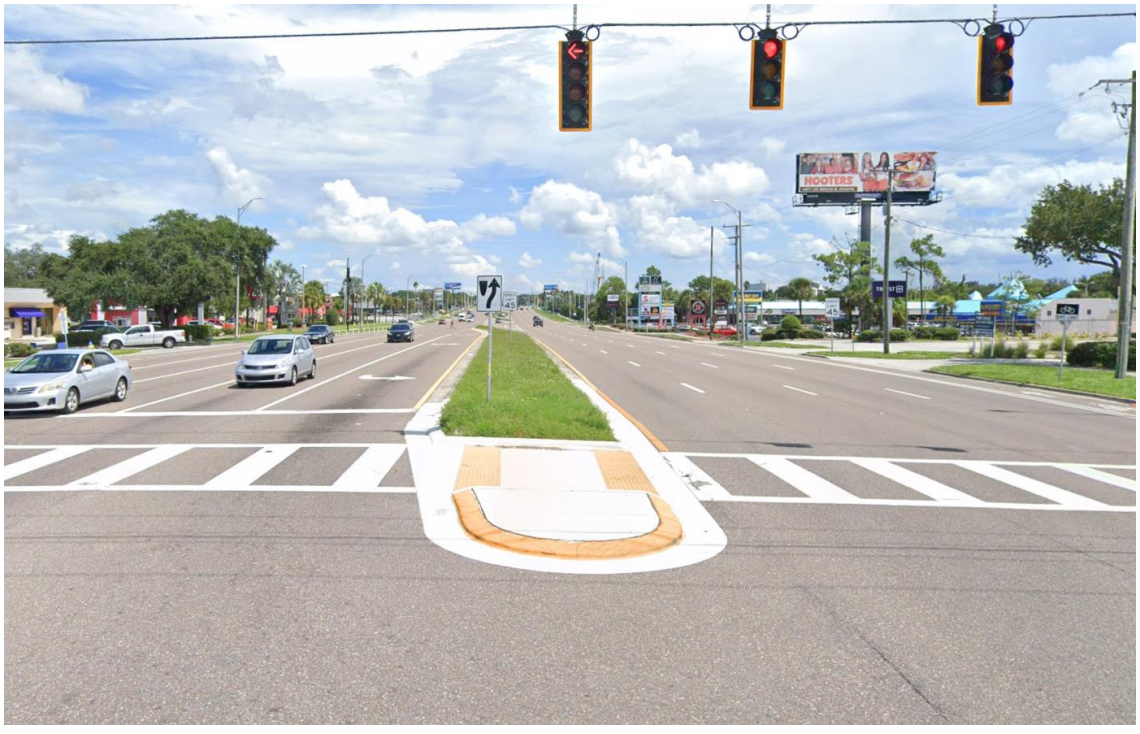

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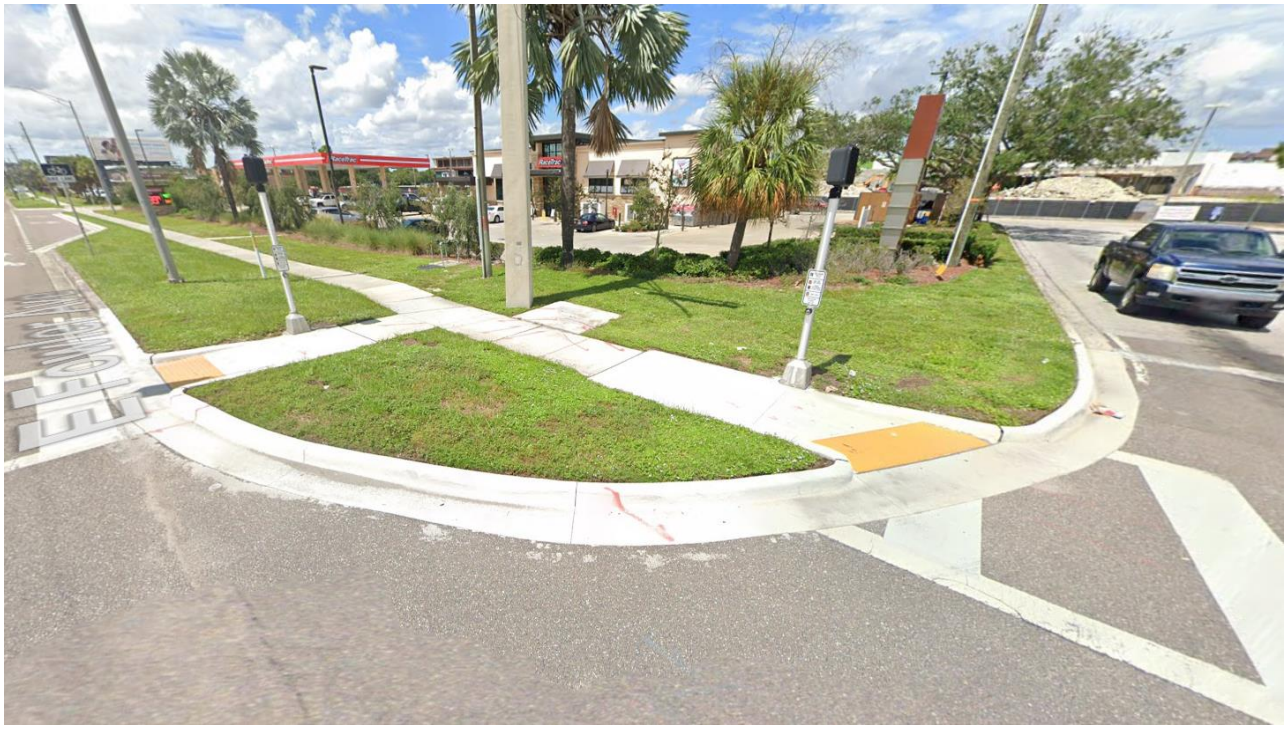

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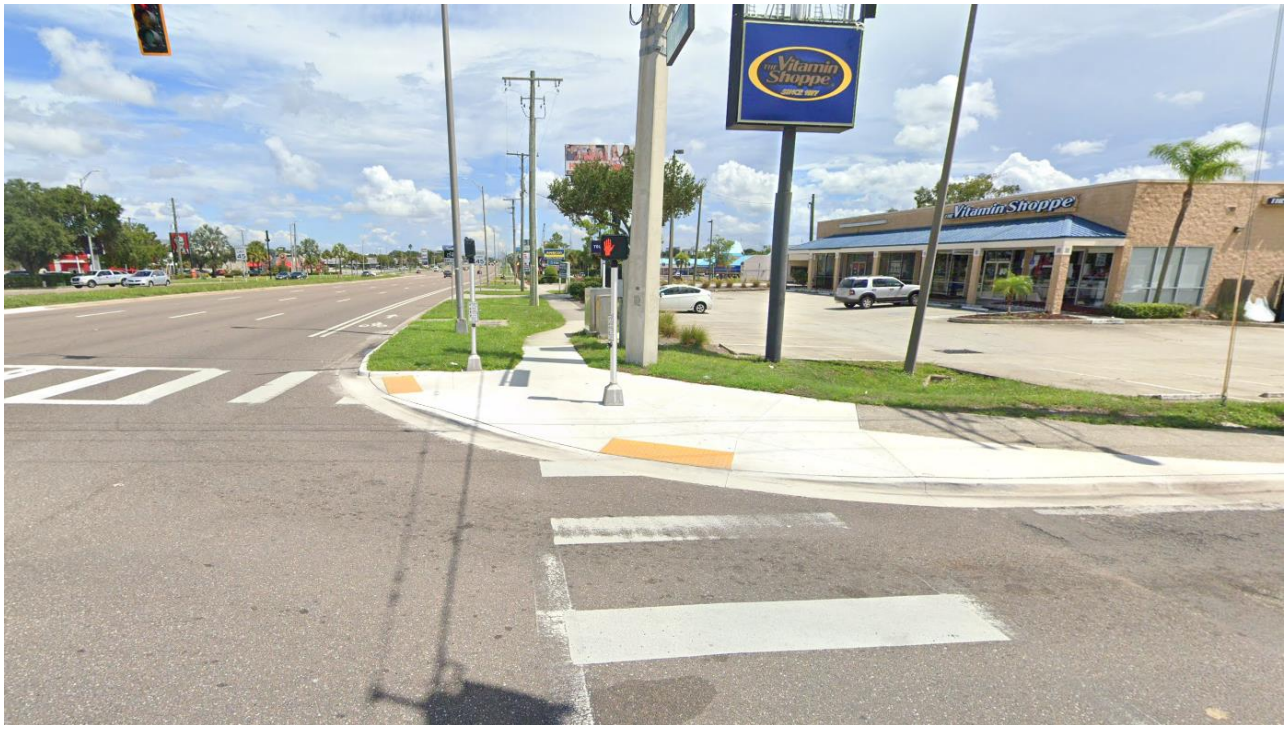

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Missing Crosswalk University Collection

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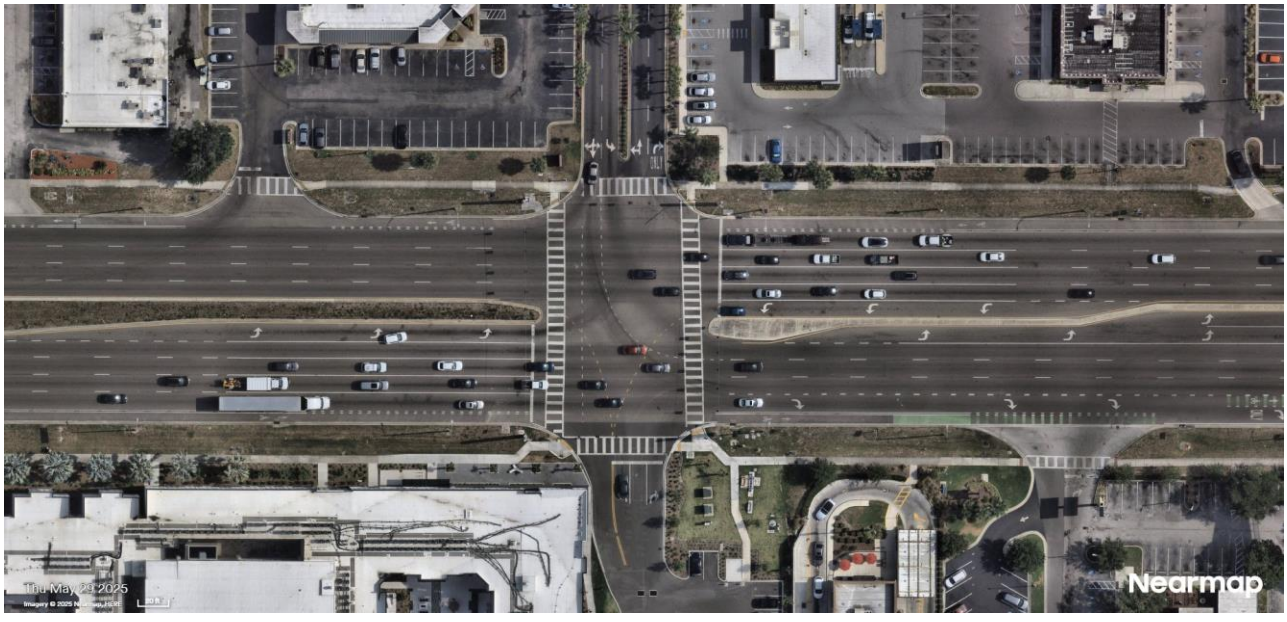

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LED Street Lighting Retrofit

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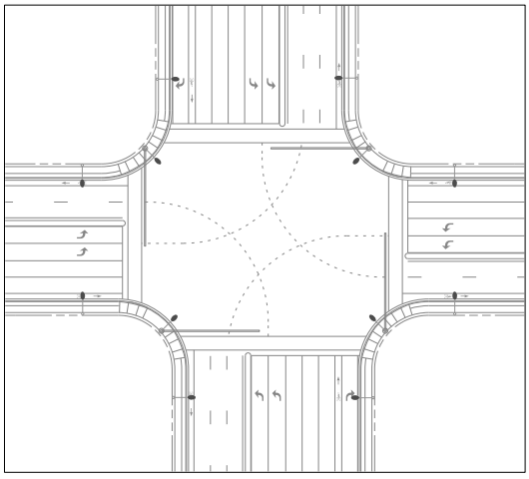
Figure 231.3.4 Typical Lighting Layout for Large Intersection



231.3.2.1.1 Intersection Lighting Retrofit

For existing signalized intersections where a full signal upgrade is not occurring, the existing infrastructure may restrict the placement of additional lighting structures necessary to meet the New and Reconstructed criteria of ***Table 231.2.1***. With these challenges considered, ***Table 231.2.1*** provides reduced illumination requirements which may be used for Intersection Lighting Retrofit designs. These retrofits provide safety benefits of improved lighting without the full reconstruction of light and signal structures.

Lighting retrofits should be considered for use at existing signalized intersections that have a history of nighttime pedestrian crashes. Lighting retrofits may be included with

RRR and minor intersection improvement projects that do not include full signal reconstruction. An Intersection Lighting Retrofit operation may include replacing older luminaire types with LED luminaires, adding additional light poles, adding luminaire support arms to existing structures, and any other minor modifications needed to meet the Lighting Retrofit requirements of ***Table 231.2.1***. Lighting retrofits generally do not include removing or replacing existing structures such as light poles and signal structures.

For Intersection Lighting Retrofit designs, the vertical illuminance requirement of ***Table 231.2.1*** only applies to crosswalks for the near side movement (see ***Figure 231.3.1***) as well as any channelized right-turn lanes per ***FDM 231.3.4***.

Existing, low-mounted sidewalk lighting is generally not intended to meet the lighting requirements of ***Table 231.2.1***. To prevent increased glare, do not increase light output at existing luminaire locations with mounting heights less than 30 feet.

Evaluate new and existing structures in accordance with ***FDM 261.***

Independent maintenance operations that update existing fixtures to LED fixtures are not considered Intersection Lighting Retrofits for design and planning purposes.

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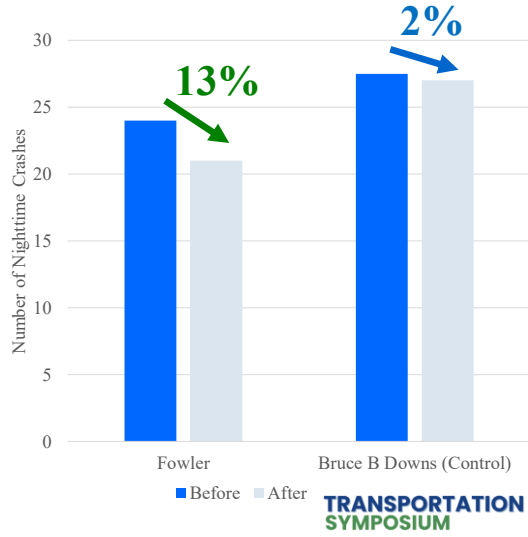
LED Street Lighting Retrofit

- From 2021-2022, D7 retrofitted streetlights with LEDs along 3.5 miles of Fowler Avenue.
- The project area saw a **13% reduction in nighttime crashes**, while the control area saw only a **2% reduction**.



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223.2.1.1 Bicycle Lane Width

The width of the bicycle lane is measured from the edge of travel lane to the edge of pavement. For new construction projects when a bicycle lane has been selected as the bicycle facility, a 7-foot buffered bicycle lane is the standard. A buffered bicycle lane has a double-6-inch white edge line separating the bicycle lane and the adjacent travel lane.

Buffered bicycle lanes are depicted in ***Exhibit 223-1***. A buffered bicycle lane should not exceed 7 feet in width (including the buffer). Any additional pavement width that results from restricting the buffered bicycle lane to 7 feet in width should be applied to the outside travel lane.

For projects where a bicycle lane is needed and it is not practical to move the existing curb (e.g., RRR), the width of the bicycle lane depends on the width of the available roadway pavement. For these types of projects, the options in the order of priority are:

(1) 7-foot buffered bicycle lane
(2) 6-foot buffered bicycle lane
(3) 5-foot bicycle lane
(4) 4-foot bicycle lane

Do not place a bicycle lane with less than 5 feet of width adjacent to a 10-foot traffic lane.

When roadway pavement is continuous to the face of guardrail or barrier, the minimum bicycle lane width is 5 feet. See ***FDM 223.2.1.3*** when the bicycle lane is adjacent to a right-turn lane or bus bay.

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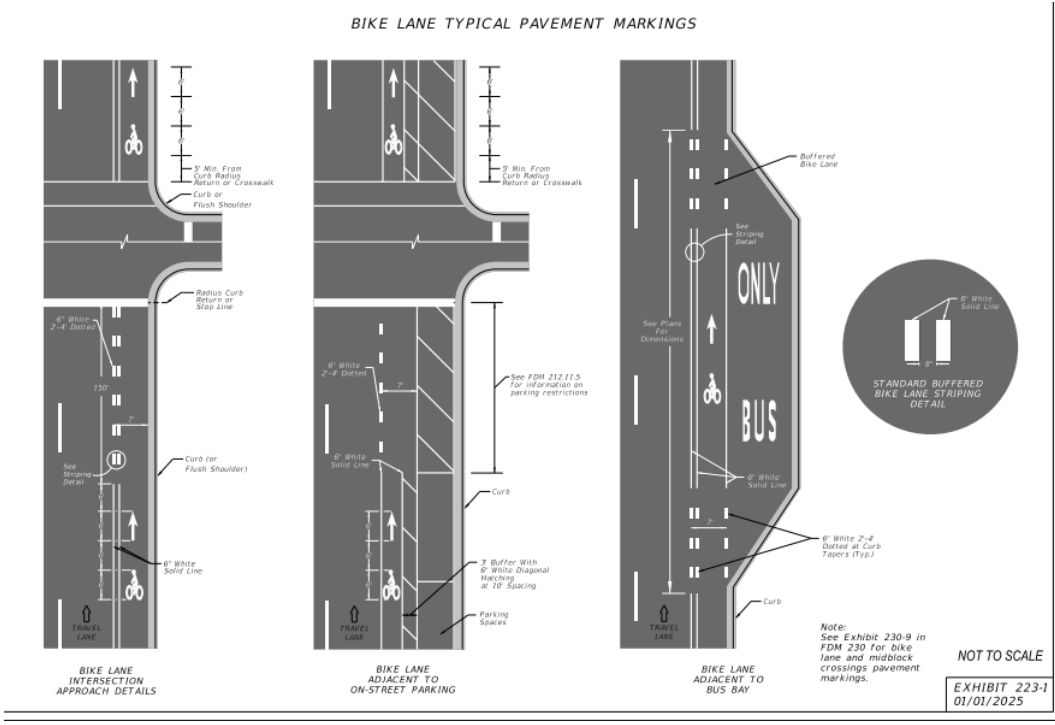

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Buffered Bike Lane

- FDOT added flex post delineators on Fowler Avenue near the University Mall in late 2019.
- This increased drivers' awareness of bicyclists and reduced bike related crashes.

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Leading Pedestrian Interval

- Gives pedestrians the opportunity to **establish their presence** in the crosswalk at an intersection **3-7 seconds** before vehicles are given a green indication.
  - Enhanced safety for pedestrians who may be slower to start into the intersection
  - Increased visibility
  - Reduced conflicts
- **Can reduce pedestrian-vehicle crashes by 13% at intersections**
- Low implementation cost

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October 28-29, 2025
Orlando, FL

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Fowler Avenue Design Applied at Another Intersection
SR 54 at Little Road

Transportation Symposium Website

SCAN ME

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Table 202.3.1 Strategies to Achieve Desired Operating Speed

Context Classification	Existing Speed Category (mph)	Minimum Design Speed (mph)	Target Speed (mph)	Strategies																	
				Roundabouts	On-Street Parking	Chicanes	Lane Narrowing	Horizontal Deflection	Street Trees	Short Blocks	Speed Tables	Raised Intersections	Raised Crosswalks (Type I Or Type II)	Speed Feedback Signs	Pedestrian Refuge Islands	Bulb-Outs	RRFBs	PHBs	Terminated Vistas	Islands in Curved Sections	Speed Pavement Markings
C2T	Low	40	40, 45	X			X	X	X	X				X	X	X		X	X		X
	Very Low	25	35	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			30	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			25	X	X	X	X	X	X	X	X	X	I	X	X	X	X	X	X	X	X
C3R, C3C	Low	40	40, 45	X			X	X	X	X				X	X	X		X	X		X
	Very Low	35	35	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X
C4	Low	40	40, 45	X			X	X	X	X				X	X	X		X	X		X
	Very Low	25	35	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			30	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			25	X	X	X	X	X	X	X	X	X	I	X	X	X	X	X	X	X	X
C5	Very Low	25	35	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			30	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			25	X	X	X	X	X	X	X	X	X	I	X	X	X	X	X	X	X	X
C6	Very Low	25	30	X	X	X	X	X	X	X	X		II	X	X	X	X	X	X	X	X
			25	X	X	X	X	X	X	X	X	X	I	X	X	X	X	X	X	X	X

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Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● ●	● 4 5 6	● 5 6 7 9	○ 5 6 ● ●	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 ● ●
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● 5 7 9	○ 5 ● ●	○ 3 4 5 7 9	○ 3 5 ● ●	○ 3 5 ● ●	○ 3 4 5 7 9	○ 3 5 ● ●	○ 3 5 ● ●
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● 5 6 7 9	○ 5 6 ●	○ 3 4 5 6 7 9	○ 3 5 6 ●	○ 3 5 6 ●	○ 3 4 5 6 7 9	○ 3 5 6 ●	○ 3 5 6 ●
4+ lanes with raised median (2 or more lanes in each direction)	● 3 5 7 8 9	● 3 5 7 8 9	○ 3 5 8 ●	○ 3 5 7 8 9	○ 3 5 ● 8 ●	○ 3 5 8 ●	○ 3 5 7 8 9	○ 3 5 8 ●	○ 3 5 8 ●
4+ lanes w/o raised median (2 or more lanes in each direction)	● 3 5 6 7 8 9	○ 3 5 ● 7 8 9	○ 3 5 6 8 ●	○ 3 5 ● 7 8 9	○ 3 5 6 ● 8 ●	○ 3 5 6 8 ●	○ 3 5 6 7 8 9	○ 3 5 6 8 ●	○ 3 5 6 8 ●

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning sign
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Lane Repurposing
9 Pedestrian Hybrid Beacon (PHB)**

*Refer to Chapter 4, 'Using Table 1 and Table 2 to Select Countermeasures,' for more information about using multiple countermeasures.
**The PHB and RRFB are not both installed at the same crossing location.

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Key Takeaways

- Tight Right Turn
  - Increased pedestrian visibility and reduced exposure
  - Speed management
- Bulb Outs
  - Shorter crosswalk distance
  - Speed management
- Median Refugee
- Corridor LED streetlight retrofit
  - Low cost, high return on investment
- Value of Evaluation
- Successful Design is Used in Other Projects

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Safety Message

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Contact Us

Tina Russo
Tina.Russo@dot.state.fl.us
(813)975-3689

Allie Caldwell
Carey.Caldwell@dot.state.fl.us
(813)766-0365

Andrew Gray
Andrew.Gray@dot.state.fl.us
(813)975-3688

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